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A simple model for x-ray sensitivity of microchannelplate-based x-ray framing cameras*

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Abstract

Gated, microchannel-plate-based (MCP) framing cameras have been deployed worldwide for 0.2 - 7 keV x-ray imaging[1-4] and spectroscopy[5] of 0.1 - 10 ns duration plasma phenomena. In addition, the progression to larger lasers and targets and higher plasma temperatures in inertial confinement fusion (ICF) research will lead to time-resolved measurements at higher photon energies (10 - 20 keV). Present and future MCP users either need complete information on the complicated angular and spectrally-dependent sensitivity of these MCPs, or predictive capabilities based on modelling validated by a few select measurements, as described here. Previous characterization[6-11] has addressed dc non-imaging applications under unspecified MCP gain conditions, with limited data at the multi-keV photon energies relevant to ICF. We present systematic measurements of dc angular sensitivity at discrete photon energies. In addition, by varying the gain on the plate, we are able to confirm the transition from single surface photoelectron production at low photon energies (< 2 keV) to multiple, distributed x-ray-pore interactions at high photon energy (> 5 keV). Finally, the relative photoelectron production efficiency between the gold conductive ends and the leaded glass matrix is inferred from the angular sensitivity. The results have been accurately modelled by using a simple 2D approximation to the 3D nature of the MCP and by averaging over all possible photon ray paths. The implications of the model to pulsed operation, to temporal and spatial smearing for the penetrating harder x-rays, and to the need to increase signals above ultra-hard x-ray fogging levels are also discussed.

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